

Constructing Geomembrane T-Seams

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Introduction

When installing geomembranes, welding **T-seams** also referred to as butt joints is an unavoidable requirement. T-seams occur at panel intersections, corners, and transition areas, creating a three-dimensional, three-layer overlap that forms a “T” configuration. This geometry makes T-seams more challenging to weld and test compared to standard two-layer seams, whether using a solid hot wedge, dual-track hot wedge, or chemical adhesive seam.

If not properly constructed and sealed, T-seams can be **critical leak points**. Currently, there are no ASTM standard test method or preferred industry-standard specification defining the method of constructing T-seams. For HDPE and LLDPE, project designers often specify their preferred method of performing T-Seams, but practices by geographical region and market sector vary widely. The most standard approach today is using a patch or cap strip shown in figure 1, however extrusion fillet, as shown in figure 2, is also commonly used. Both methods require meticulous preparation and execution by experienced welding technicians. Patches are also the standard method for thinner gauge flexible geomembranes including both reinforced and non-reinforced materials.



Figure 1 – Patched / Cap Strip T-Seam - HDPE



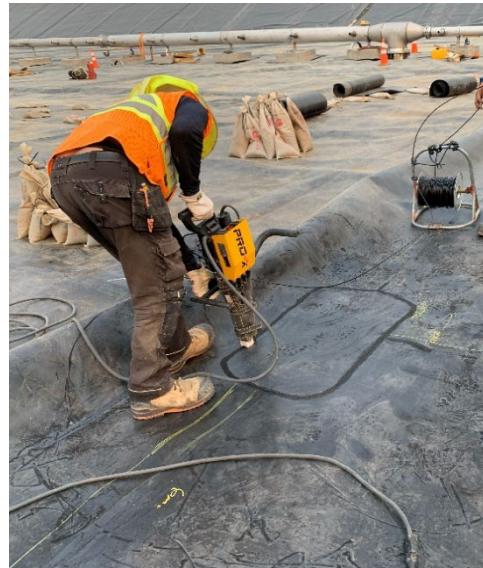
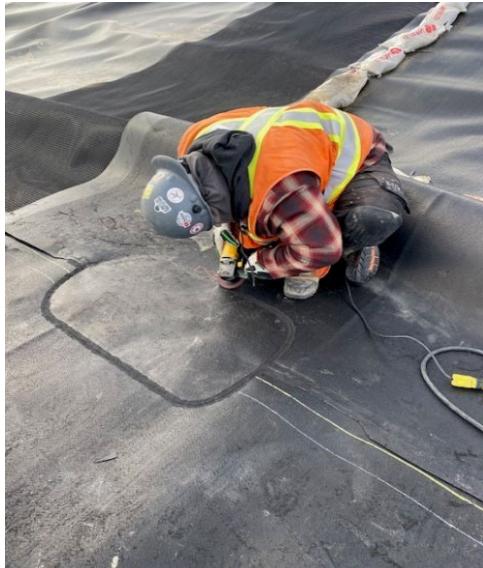
Figure 2 – Extrusion Fillet T-Seam - LLDPE

The **International Association of Geosynthetic Installers (IAGI)** does not advocate a preferred method, whether patch/cap strip or extrusion fillet. Both approaches must be properly performed by experienced, skilled welding technicians and verified using appropriate non-destructive testing (NDT) methods. There are subtle differences in the methods of performing and testing T-Seams by geomembrane material type and structure. All standard thermoplastic geomembranes installed in the field, including HDPE, LLDPE, PVC and most reinforced geomembranes including PVC-EIA, CSPE, RPP, and RPE, will have T-seams that require either extrusion or hot air welding or the use of chemical adhesives. As thermal fusion extrusion and hot air welding for T-Seams require another heat cycle to the liner, care must be taken not to excessively overheat the material.

Methods for Sealing T-Seams

Patch (Cap Strip) Method

- **Geometry:** Patch shall extend ≥ 150 mm (6 in) beyond the T-intersection in all directions (or as specified by the project).
- **Corners:** Use **rounded corners** (radius ≥ 50 mm / 2 in) to reduce stress concentration.
- **Preparation:** HDPE & LLDPE, grind the underlying seam area to remove oxidation.
- **Welding:** HDPE & LLDPE, properly clean the sheet and apply thermal fusion extrusion fillet welding around the entire perimeter of the patch, ensuring complete encapsulation and no fish-mouths.



Photos showing grinding and extrusion welding of HDPE T-Seam patches

Extrusion Weld (Fillet) Method (No Patch)

- **Preparation:** Edge flap for the previous field seams or factory panel welds must be trimmed back prior to welding across them to ensure the machine makes full contact with the underlying sheet.
- **Grind and clean** all surfaces at the T-intersection; feather edges to avoid steps. For seams created using a dual-track wedge, ensure the air channel at the T-intersection is sealed by proper grinding and extrusion welding.
- **Extrusion:** Apply a continuous, uniform fillet bead sized to design (commonly $\geq 10-15$ mm toe width, depending on sheet thickness). Ensure material is properly cleaned.
- **Multiple Passes:** Avoid multiple passes whenever possible as each pass introduces an extra cycle which can have a negative effect leading to potential longer term failure. The size of the extrusion bead should be constant and defined ensuring weld integrity and strength.



Extrusion fillet weld of T-Seam

Non-Destructive Testing (NDT)

Perform NDT on **100% of T-seams** (patch perimeters and extrusion fillets) as per ASTM D4437.

Vacuum Box Testing: If a T-seam cannot be air-pressure tested (e.g., if it was repaired with an extrusion weld or patch), it must be tested using a vacuum box according to ASTM D5641.

- **Procedure:**
 1. Apply leak detection fluid on the seam.
 2. Place vacuum box; draw vacuum to specified **level (typically - 7 to 28 kPa / -1 to 4 psi)**.
 3. Hold ≥ 10 seconds; observe for bubble formation.
 4. Progressively overlap tests to ensure full coverage.
- **Acceptance:** No continuous or intermittent bubbling. Isolated cosmetic bubbling (not linked to seam) must be investigated.



Mechanical Point Stress Testing

- **Procedure:** Apply controlled, localized pressure at seam toe/fillet edges with a rounded tool to probe for poor welds and voids.
- **Acceptance:** Seam remains intact without cracking, lifting, or audible separation.

Air Channel Integrity

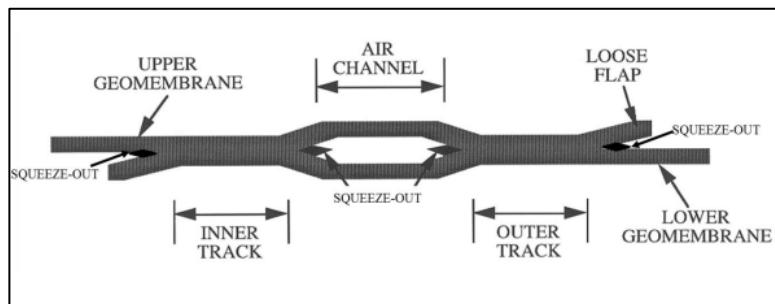
Air Channel Testing: This is the preferred method for dual-track seams. If the pressure holds at the "T," the junction is secure. Follow air channel testing in accordance with ASTM D5820.

- **Procedure:** Pressurize the channel to specified pressure; hold for specified duration; observe decay limits per project spec.
- Equipment for testing dual track fusion seams shall be comprised of but not limited to an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 205 kPa (35 psi). Air pressure is related to the thickness and stiffness of the various geomembrane types and varies from 70 to 205 kPa (10 to 35 psi).
- **Note:** For HDPE and LLDPE geomembranes, each T-seam air channel needs to be individually sealed off and tested, followed by vacuum box testing of the full extrusion T-Seam. This extra step should not be skipped.



Air pressure testing dual track PVC liner weld

Visual Inspection: Technicians look for any "fishmouths" or excessive wrinkles at the overlap, which must be cut, keyed (keyhole cut), and patched with an oval patch extending at least 150mm (6 inches) in all directions.



GRI GM6 - Configuration of a Dual Track Geomembrane Seam

Electrical Spark Testing

- Utilizing conductive geomembrane or conduct media, electrically spark test the geomembrane in accordance with ASTM D6365 or ASTM D7240.

Summary

Achieving zero or minimal acceptable leakage rates in containment systems demands meticulous attention to every phase—design, material selection, earthworks, geomembrane installation, and comprehensive CQA. Among these, the proper installation and testing of T-Seams is critical and requires highly skilled welding technicians.

The International Association of Geosynthetic Installers (IAGI) promotes adherence to industry best practices, emphasizing **Safety, Quality, and Productivity** in geosynthetic installations. Following

these practices helps reduce injury risks, ensure installation integrity, and deliver optimal project performance. For more information on IAGI's Certified Welding Technician (CWT) program or Approved Installation Contractor (AIC) certification, contact IAGI at IAGI@IAGI.org.

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- **Photos Courtesy of Demtech, EPI, GSI, Lester, Layfield**

References

- **ASTM D4437/D4437M-16(2023)**: Standard Practice for Nondestructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
- **ASTM D5820-95(2023)**: Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.
- **ASTM D7177/D7177M-21**: Standard Specification for Air Channel Evaluation of Polyvinyl Chloride (PVC) Dual Track Seamed Geomembranes
- **ASTM D5641/D5641M-16 (2024)** - Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
- **ASTM D7240-18**: Standard Practice for Electrical Leak Location (Conductive Geomembrane Spark Testing
- **Flexible Geomembrane Institute - FGI-10-24** Factory Fabrication Guideline
- **GRI Test Method GM6** - Standard Practice for "Pressurized Air Channel Test for Dual Seamed Geomembranes
- **GRI GM19**: Geosynthetic Institute Specification for Seam Strength of Thermally Bonded Homogeneous Polyolefin Geomembranes (GM-19a) and Reinforced Geomembranes (GM-19b)

